CS 188 Spring 2024 Introduction to Artificial Intelligence

Exam Prep 11

Q1. Machine Learning: Potpourri

(a) What it the **minimum** number of parameters needed to fully model a joint distribution $P(Y, F_1, F_2, ..., F_n)$ over label Y and n features F_i? Assume binary class where each feature can possibly take on k distinct values.

(b) Under the **Naive Bayes assumption**, what is the **minimum** number of parameters needed to model a joint distribution $P(Y, F_1, F_2, ..., F_n)$ over label Y and n features F_i? Assume binary class where each feature can take on k distinct values.

(c) You suspect that you are overfitting with your Naive Bayes with Laplace Smoothing. How would you adjust the strength k in Laplace Smoothing?

◯ Increase k ◯ Decrease k

(d) While using Naive Bayes with Laplace Smoothing, increasing the strength k in Laplace Smoothing can:

☐ Increase training error ☐ Decrease training error
☐ Increase validation error ☐ Decrease validation error

(e) It is possible for the perceptron algorithm to never terminate on a dataset that is linearly separable in its feature space.

◯ True ◯ False

(f) If the perceptron algorithm terminates, then it is guaranteed to find a max-margin separating decision boundary.

◯ True ◯ False

(g) In binary perceptron where the initial weight vector is $\vec{0}$, the final weight vector can be written as a linear combination of the training data feature vectors.

◯ True ◯ False

(h) For binary class classification, logistic regression produces a linear decision boundary.

◯ True ◯ False

(i) In the binary classification case, logistic regression is exactly equivalent to a single-layer neural network with a sigmoid activation and the cross-entropy loss function.

◯ True ◯ False

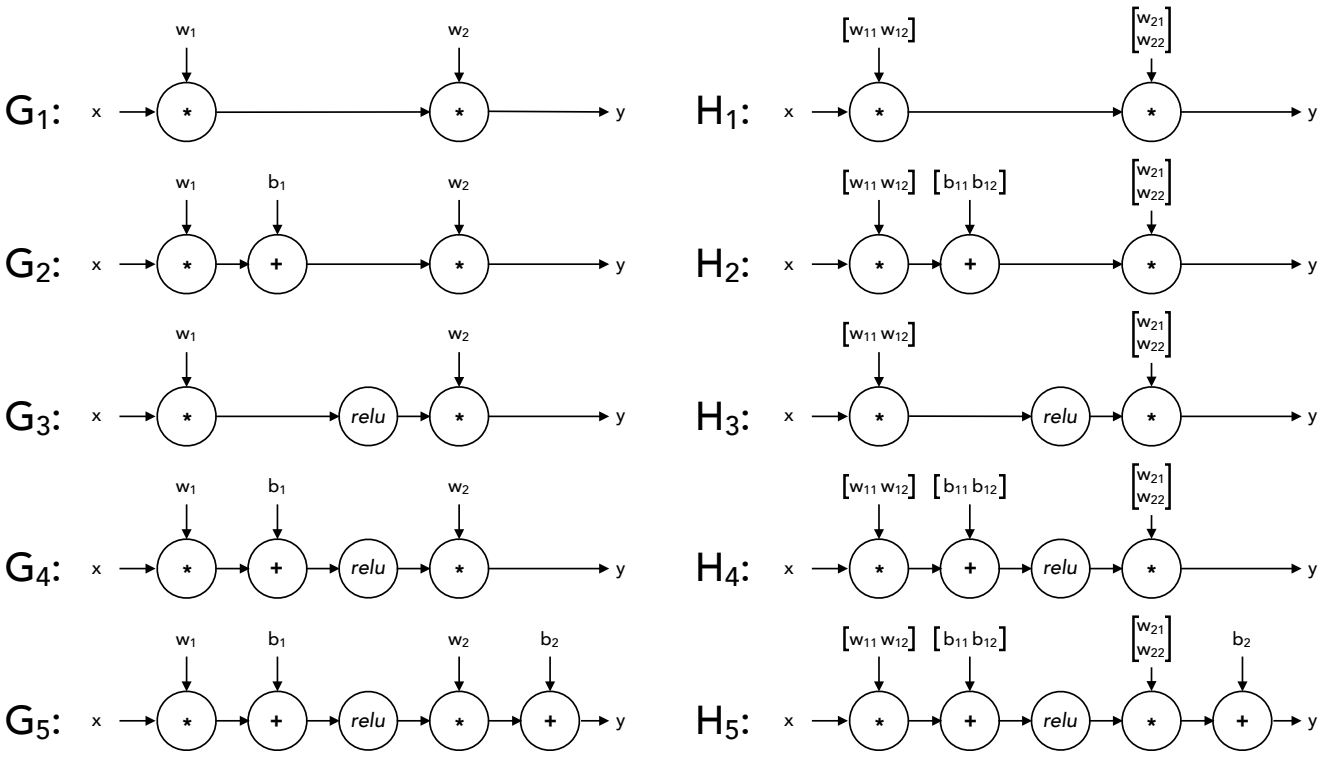
(j) You train a linear classifier on 1,000 training points and discover that the training accuracy is only 50%. Which of the following, if done in isolation, has a good chance of improving your training accuracy?

☐ Add novel features ☐ Train on more data

(k) You now try training a neural network but you find that the training accuracy is still very low. Which of the following, if done in isolation, has a good chance of improving your training accuracy?

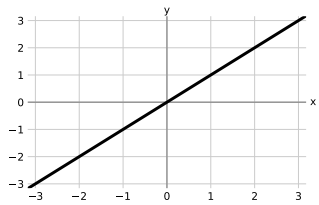
☐ Add more hidden layers ☐ Add more units to the hidden layers

Q2. Neural Networks: Representation



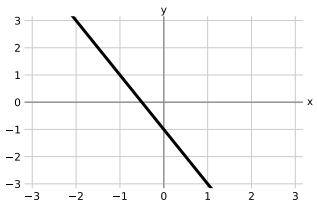
For each of the piecewise-linear functions below, mark all networks from the list above that can represent the function **exactly** on the range $x \in (-\infty, \infty)$. In the networks above, *relu* denotes the element-wise ReLU nonlinearity: $relu(z) = max(0, z)$. The networks G_i use 1-dimensional layers, while the networks H_i have some 2-dimensional intermediate layers.

(a)



☐ G_1 ☐ G_2 ☐ G_3 ☐ G_4 ☐ G_5 ☐ H_1 ☐ H_2 ☐ H_3 ☐ H_4 ☐ H_5

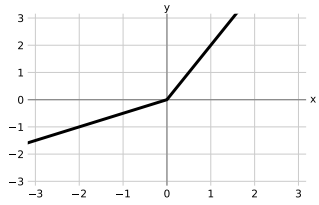
○ None of the above



☐ G_1 ☐ G_2 ☐ G_3 ☐ G_4 ☐ G_5 ☐ H_1 ☐ H_2 ☐ H_3 ☐ H_4 ☐ H_5

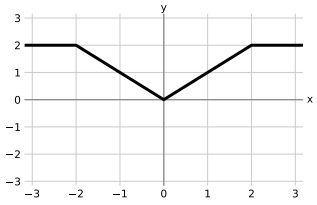
○ None of the above

(b)



☐ G_1 ☐ G_2 ☐ G_3 ☐ G_4 ☐ G_5 ☐ H_1 ☐ H_2 ☐ H_3 ☐ H_4 ☐ H_5

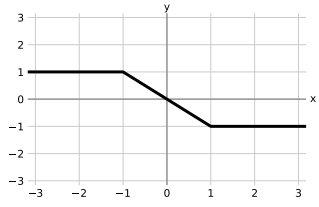
○ None of the above



☐ G_1 ☐ G_2 ☐ G_3 ☐ G_4 ☐ G_5 ☐ H_1 ☐ H_2 ☐ H_3 ☐ H_4 ☐ H_5

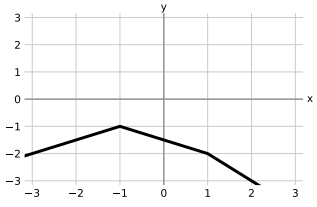
○ None of the above

(c)



☐ G_1 ☐ G_2 ☐ G_3 ☐ G_4 ☐ G_5 ☐ H_1 ☐ H_2 ☐ H_3 ☐ H_4 ☐ H_5

○ None of the above



☐ G_1 ☐ G_2 ☐ G_3 ☐ G_4 ☐ G_5 ☐ H_1 ☐ H_2 ☐ H_3 ☐ H_4 ☐ H_5

○ None of the above